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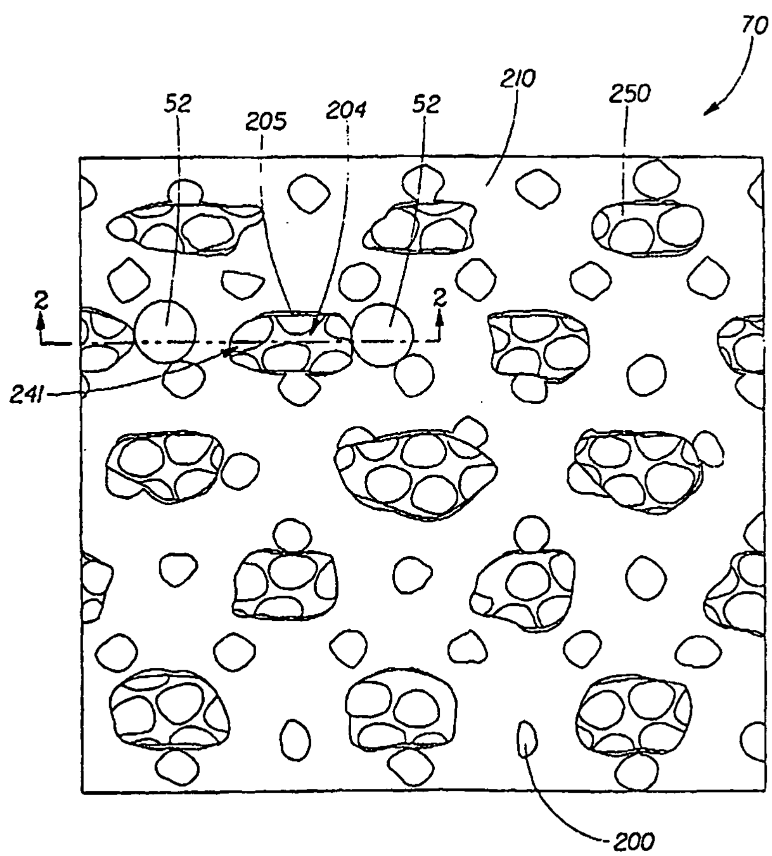
(54) Title: DUAL APERTURED COMPOSITE WEB AND ABSORBENT ARTICLES HAVING A TOPSHEET COMPRISING SUCH A WEB

(57) Abstract

A composite, laminated web (70) suitable for use as a topsheet for an absorbent article is disclosed. The web (70) is a laminate of a liquid pervious first material (210) and a liquid pervious second material (250). The first material (210) is a hydrophobic, apertured nonwoven material with an effective open area that is provided by nonwoven apertures (204) with an effective size and the second material (250) is a macroscopically expanded, fluid pervious formed film with an effective open area. The formed film is provided with capillaries (241) defined by interconnected sidewall portions. The capillaries (241) have an effective size such that each of the nonwoven apertures (204) circumscribes at least a portion of two or more of the capillaries (241). In particularly preferred embodiments, the outer surface of the nonwoven material is treated with a surface treatment with a surface energy that is lower than the surface energy of the material. Absorbent articles using the laminated web as a topsheet and a method of making the laminated web are also disclosed.



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DUAL APERTURED COMPOSITE WEB AND ABSORBENT ARTICLES HAVING A TOPSHEET COMPRISING SUCH A WEB

This is a continuation-in-part of application Serial No. 08/832,715, filed in the name of Ouelette, et al. on April 11, 1997, pending, which is a continuation of application Serial No. 08/442,935, filed on May 31, 1995,abandoned, which is a continuation-in-part of application Serial No. 08/326,571, filed on October 20, 1994, abandoned, which is a continuation-in-part of application Serial No. 08/268,404, filed on June 30, 1994, abandoned; and a continuation-in-part of application Serial No. 08/761,905, filed in the name of Bien, on December 5, 1996, pending; and a continuation-in-part of application Serial No. 08/810,205, filed in the name of Curro, et al. on March 3, 1997, pending; which is a continuation of application Serial No. 08/536,228, filed on September 29, 1995, US Patent 5,628,097.

Field of the Invention

The present invention relates to absorbent articles such as baby and adult diapers, sanitary napkins, adult incontinence pads, and the like. Still more particularly, the present invention is directed to a dual apertured, composite web that is suitable for use as a topsheet for such absorbent articles, the topsheet providing excellent skin comfort and fluid acquisition.

Background of the Invention

All manner and variety of absorbent articles configured for the absorption of bodily fluids such as menses, urine, and feces are, of course, well known. Generally, absorbent articles comprise a liquid pervious topsheet, a liquid impervious backsheet, and an absorbent core positioned between the topsheet and the backsheet. The exudates from a wearers body readily penetrate through the topsheet and are contained in the absorbent core.

The topsheet serves at least two purposes. First, the topsheet provides fluid handling properties including rapid acquisition so that bodily fluids pass through the topsheet and into the absorbent core and the minimization of rewet of those fluids absorbed by the absorbent core (i.e., fluids once absorbed into the absorbent core are deterred from leaking back through the topsheet to wet the wearers skin). Second, the topsheet provides skin comfort by being compliant, sort feeling, dry, and non-irritating to the wearers skin.

In order to provide better fluid handling characteristics and skin comfort, apertured thermoplastic films have been developed as a material for the topsheet. Apertured thermoplastic films have been preferred for the topsheet because they are pervious to liquids and yet non-absorbent. Thus, the surface of the apertured thermoplastic film which is in contact with the body remains dry and is more comfortable to the wearer. Such apertured thermoplastic films are available in the marketplace, and include films disclosed in U.S. Patent 3,929,135 which issued to Thompson on December 30, 1975; U.S. Patent 4,324,426 which issued to Mullane and Smith on April 13, 1982; U.S. Patent 4,342,314 which issued to Radel and Thompson on August 3, 1982; and U.S. Patent 4,463,045 which issued to Ahr, Louis, Mullane, and Ouellette on July 31, 1984, the disclosure of each of which being incorporated herein by reference. Such apertured thermoplastic films are also marketed as "Dri-Weave" on sanitary napkins produced by The Procter & Gamble Company of Cincinnati, OH. However, while apertured thermoplastic films provide excellent dryness and rewet properties, further improvements in skin feel and comfort are desirable. In particular, some users have complained that apertured thermoplastic films can feel hot, sweaty, or sticky.

The art has attempted to address the comfort issues of apertured thermoplastic films in various ways. For example, PCT application Serial No. WO 93/09744, published in the name of Sugahara on May 27, 1993 and Japanese Utility Model No. Hei 1(1989)-122727 describe sanitary napkins having a two layer topsheet wherein the topsheet has a central zone comprising an apertured thermoplastic film and outer zones wherein a nonwoven overlies the apertured thermoplastic film (i.e., there is a relatively large opening where the apertured thermoplastic film is exposed). While such two layered topsheets may represent some improvement in comfort because of the partial nonwoven coverage, there is still substantial direct bodily contact with an apertured thermoplastic film suggesting that the comfort issues discussed above would not be completely obviated.

The art has also investigated two layer structures wherein a nonwoven layer overlays an apertured formed film layer. The are two groups of structures of this type: 1) structures where the

nonwoven layer is not apertured and 2) structures where the nonwoven layer is apertured. Exemplary patents describing the first group include: U.S. Patent 3,878,014, issued to Melead on April 15, 1975; US Statutory Invention Registration (SIR) No. H1670, published in the name of Aziz, et al. on July 1, 1998; PCT Application No. WO 98/16177, published in the name of Chatterjee on April 23, 1998, and PCT Application No. WO 98/25759, published in the name of Bien on June 18, 1998. Exemplary patents describing the second group include: Japanese Laid Open Application No. 2-193663, published in the name of Uni Charm Co., Ltd. on July 31, 1990 and US Patent No. 5,171,238 issued in the name of Kajander on December 15, 1992. While such structures may overcome the comfort issues that may exist for the materials discussed in the preceding paragraphs, the structures may not be able to handle bodily fluids in a manner that that provides a clean, dry surface. For example, if a nonapertured nonwoven (i.e. a group 1 structure) is not sufficiently hydrophobic (e. g. the surfactant-treated nonwovens described in aforementioned SIR H1670), the underlying film may incompletely remove acquired bodily fluids from the nonwoven layer. Conversely, if a nonapertured nonwoven is hydrophobic, passage of aqueous liquids through the nonwoven layer will be hindered because such aqueous liquids do not wet the nonwoven layer. Group 2 structures (i.e. apertured nonwoven) are typically perforated after the nonwoven layer and the film layer are joined so the apertures are approximately the same size and share a common vertical axis. As a result, balancing fluid acquisition and rewet becomes difficult.

Thus, there is a continuing need for improved web structures suitable for use as topsheets for absorbent articles. In particular, there is a need for improving the balance between fluid acquisition, wearer comfort, stain resistance, and rewet resistance. Further, there is a need for improved structures that combine the fluid handling benefits of formed films and the comfort benefits of nonwovens.

Summary of the Invention

The present invention is a composite, laminated web that is suitable for use as a topsheet material for an absorbent article. The web comprises a substantially hydrophobic, apertured nonwoven layer and a hydrophilic, apertured formed film layer. The apertures in the nonwoven layer have an effective size of at least about 1 mm^2 and an open area of at least about 10 percent. The apertures of the formed film layer have an effective size of at least about 10% less than the effective size of the nonwoven apertures and serve as capillaries that draw bodily fluids away from the nonwoven layer and toward an absorbent core when the web is used as a topsheet. Because the effective size of each nonwoven aperture is larger than the effective size of a film

aperture and the open area of the nonwoven layer is equal to or less than the open area of the formed film layer, each nonwoven aperture circumscribes at least a portion of two or more film apertures. The present invention also includes absorbent articles, such as catamenial devices, that use such webs as a topsheet.

Brief Description of the Drawings

Figure 1 is a plan view of a portion of the composite web of the present invention, partially cut away to show underlying structure.

Figure 2 is an enlarged cross sectional view of a preferred embodiment of the composite web of the present invention taken along line 2–2 of Figure 1.

Figure 3 is an enlarged, partially segmented, perspective illustration of a particularly preferred embodiment of an apertured, macroscopically expanded, three-dimensional, fluid-pervious, formed film generally in accordance with the teachings of commonly assigned U.S. Pat. No. 4,342,314.

Figure 4 is a schematic diagram showing a method of forming the web of the present invention.

Figure 5 is a top plan view of a sanitary napkin embodiment of the present invention, the topsheet facing the viewer.

Figure 6 is an enlarged lateral cross-sectional view taken along line 4–4 of Figure 5.

Detailed Description of the Invention

Dual Apertured Composite Web

In one embodiment, the present invention comprises a dual apertured, composite web 70. The web 70, as is shown in Figures 1 and 2, comprises a nonwoven layer 210 and an apertured thermoplastic film layer 250. Each of the layers 210, 250 has an outer surface designated by the suffix A (i.e. 210A and 250A) and an inner surface designated by the suffix B (i. e. 210B and 250B) The inner surface 210B of nonwoven layer 210 is secured in at least partial contacting relation with the inner surface 250B of the apertured thermoplastic film layer 250 to form the composite web 70. The nonwoven layer 210 can be maintained in contact with the apertured thermoplastic film layer 250 by thermal bonding, adhesive attachment of the layers, the combination of heat and pressure commonly known as crimping, or other securement means as may be known to the art. The two layers can be continuously, partially, or intermittently bonded together. In a preferred embodiment, the nonwoven layer 210 and the apertured thermoplastic

film layer 250 are ultrasonically spot-bonded at a plurality of positions to form the composite web 70.

Nonwoven Layer

The nonwoven layer 210 provides a soft body facing surface when the web 70 is used as a topsheet (This alternative embodiment of the invention is discussed in greater detail below). Such a surface helps to address the sticky, sweaty feeling reported by some users of apertured, formed film topsheets. The nonwoven layer 210 should have excellent flexibility so as to allow a topsheet made therefrom to readily conform to the contours of a wearer's body.

A suitable material for use as the nonwoven layer 210 preferably comprises thermoplastic fibers to facilitate bonding to the apertured thermoplastic film layer 250 and formation of the nonwoven apertures 204 as is discussed below. The nonwoven layer 210 is also hydrophobic. As will be discussed in greater detail below, when the composite web 70 is used as a topsheet for an absorbent article, such a hydrophobic nonwoven layer 210 encourages transport of bodily fluids away from the body surface of such absorbent articles, helping the surface remain clean, dry and improving wearer comfort. The nonwoven layer 210 can be rendered hydrophobic by forming the nonwoven structure using hydrophobic fibers. Alternatively, the nonwoven layer 210 can comprise hydrophilic fibers and be rendered hydrophobic using means known to the art, such as treatment with a fluorocarbon or silicon material. Suitable fluorocarbon materials include those available from DuPont Specialty Chemicals, Wilmington, DE as ZONYL® and from 3M, Specialty Chemicals Division, St. Paul, MN. Particularly preferred are ZONYL® 6991 from DuPont and FC–280 from 3M. As used herein a surface is "hydrophilic" if the contact angle of water disposed on that surface is less than about 90° and a surface is "hydrophobic" if the contact angle of water disposed on that surface is greater than or equal to 90°.

Suitable precursor nonwoven webs may be produced by any of the means known to the art for making a nonwoven. Exemplary means include: carding, airlaying, meltblowing, and spunbonding. Preferred are known nonwoven extrusion processes, such as, for example, known meltblowing processes or known spunbonding processes.

The nonwoven web may be extensible, elastic, or nonelastic. The nonwoven web may be a spunbonded web, a meltblown web, an airlaid web, or a bonded carded web. If the nonwoven web is a web of meltblown fibers, it may include meltblown microfibers. The nonwoven web may be made of natural fibers such as wood, cotton, or rayon, or synthetic fibers such as polypropylene, polyethylene, polyester, ethylene copolymers, propylene copolymers, and butene

copolymers, bicomponent fibers, or combinations of natural and synthetic fibers. As noted above, at least a portion of the fibers need to be thermoplastic and are preferably hydrophobic.

The nonwoven web may be a multilayer material having, for example, at least one layer of a spunbonded web joined to at least one layer or a meltblown web, a bonded carded web, or other suitable material. Alternatively, the nonwoven web may be a single layer or material, such as, for example a spunbonded web, a bonded carded web, or a meltblown web.

The nonwoven web may also be a composite made up of a mixture of two or more different fibers or a mixture of fibers and particles. For example, when using a meltblowing process to produce the web, such mixtures may be formed by adding fibers and/or particulates to the gas stream in which the meltblown fibers are carried so that an intimate entangled co-mingling of meltblown fibers and other materials, e.g., wood pulp, staple fibers and particles occurs prior to collection of the meltblown fibers upon a collecting device to form a coherent web of randomly dispersed meltblown fibers and other materials.

The nonwoven web of fibers should be joined by bonding to form a coherent web structure. Suitable bonding techniques include, but are not limited to, chemical bonding, thermobonding, such as point calendering, hydroentangling, and needling. A particularly preferred way of joining the fibers of the nonwoven web is to use point bonds which are shown as 200 in Figure 1.

Nonwoven webs that are suitable precursors for the nonwoven layer 210 the present invention have a basis weight of between about 10 grams/m^2 and about 100 grams/m^2. Preferably, the basis weight is between about 10 grams/m^2 and about 70 grams/m^2. One suitable starting web for transformation into a nonwoven layer 210 is a spunbonded polyethylene web having a basis weight of about 30 grams/m^2 which is available BBA Nonwovens, Corovin GmbH of Peine, Germany under the trade name COROLIND. A particularly preferred means of aperturing such a starting web for use as a nonwoven layer 210 of the present invention is described in U.S. Patent 5,628,097, issued to Benson and Curro on May 13, 1997, the disclosure of which is incorporated herein by reference.

After transformation, the nonwoven layer 210 of the present invention has a plurality of nonwoven apertures 204 and a basis weight of between about 5 grams/m^2 and about 70 grams/m^2. Preferably, the basis weight is between about 10 grams/m^2 and about 50 grams/m^2. After transforming the particularly preferred starting web discussed above into a nonwoven layer 210 the particularly preferred nonwoven layer 210 has a basis weight of about 15 grams/m^2.

Alternatively, if a more cottony feel is desired, the starting web can comprise a spunbonded polyethylene web and can have a basis weight of about 60 grams/m^2 and a transformed basis weight of about 30 grams/m^2. Such alternative starting webs are also available from BBA Nonwovens, Corovin GmbH of Peine, Germany.

The plurality of nonwoven apertures 204 renders the nonwoven layer 210 liquid permeable. Such apertures 204 allow bodily fluids to pass through the nonwoven layer 210 to underlying structure (even though the nonwoven layer 210 is hydrophobic) when the dual apertured composite web 70 of the present invention is used as a topsheet. The apertures 204 may be provided by any means known to the art. Exemplary means include: die cutting and hydroaperturing (where a pattern of water jets rearranges the fibers making up the nonwoven to provide a pattern of apertures). A particularly preferred means of providing the apertures 204 to the nonwoven layer 210 of the present invention is described in the aforementioned U.S. Patent 5,628,097. As described therein, the precursor nonwoven web is weakened and melt stabilized by melting the thermoplastic fibers at a plurality of sites. The web is then ruptured at the weakened sites by application of a tension force to the web which spreads the web and creates a plurality of apertures, such as nonwoven apertures 204, in the web and transforms the precursor web into a suitable nonwoven layer 210. As can also be seen in Figure 1, this preferred method of providing nonwoven apertures 204 also provides remnants 205 of the melt stabilized locations which are believed to help stabilize the apertures 204 and resist further tearing.

The effective size of the nonwoven apertures 204 is important with respect to the present invention. As used herein the "effective size" of an aperture is the average aperture surface area when measured according to the method described in the TEST METHODS section below. As would be recognized by one of skill in the art, the size of an aperture 204 is important in that it helps control fluid flow through the aperture. That is, if the aperture 204 is too small fluids will flow through the aperture slowly, if at all. For example, viscous forces in a bodily fluid, such as menses, can overcome any capillary forces that would tend to draw the fluid through an aperture 204 if the effective size is too small so as to hinder fluid flow through the aperture. In the extreme, such viscous fluids can bridge very small apertures 204 with little or no fluid flow through the apertures. Conversely, if the effective size is too large, underlying structure may be exposed to a wearer's skin when the web 70 is used as a topsheet. Such exposure can partially suppress the skin comfort benefits of the present invention. Suitably, the effective size of a nonwoven aperture 204 is between about 1 mm^2 and about 10 mm^2. Preferably, the effective size

is between about 1 mm^2 and about 8 mm^2, more preferably, between about 2 mm^2 and about 5 mm^2.

The effective size and the number of nonwoven apertures 204 cooperate to define the percent open area for the nonwoven layer 210. As used herein, the "percent open area" is the percentage of the surface area of a plan view of the nonwoven layer 210 not occupied by fibrous material as determined according to the method described in the TEST METHODS section below. Again, one of skill in the art will recognize that percent open area can be either too small or too large. If the percent open area is too small, an absorbent article using the web 70 as a topsheet may be unable to acquire bodily fluids deposited on the body surface of the topsheet sufficiently quickly to prevent such fluids from flowing over the body surface until the fluid comes to an edge of the absorbent article (When bodily fluids are adjacent to an edge of an absorbent article the risk of such fluids leaking is substantially increased). If the percent open area is too large, the risk of exposing the formed film with the resultant increase in potential for wearer discomfort may become unacceptably large. Suitably, the percent open area of a nonwoven aperture 204 is between about 10 percent and about 40 percent. Preferably, the percent open area is between about 15 percent and about 35 percent; more preferably, between about 15 percent and about 25percent.

It is also within the scope of the present invention for the nonwoven layer 210 to have a pattern of apertures such that a first portion of the pattern has apertures having a first effective size and a first percent open area and a second portion has a second effective size and a second percent open area. Such a pattern would be useful, for example, for designs where a larger effective size and percent open area would facilitate acquisition of bodily fluids during high flow situations but such larger effective size and percent open area were not, necessarily, desirable over the entire surface of a particular absorbent article. It should also be recognized that patterns having more than two such portions with differing effective size and percent open area are also contemplated.

Preferably, the nonwoven layer 210 comprises hydrophobic fibers (e. g., the polyethylene fibers described above). More preferably the outer surface 210A is treated to further increase the hydrophobicity in at least spaced apart regions thereof. As used herein, the hydrophobicity of a surface is increased if the surface energy of the surface is reduced. The energy required to separate a liquid from a solid surface (e.g., a film or fiber) is expressed by equation (1):

$$(1) \qquad W = \Gamma\,(1 + \cos\alpha)$$

where:

W is the work of adhesion measured in erg/cm^2,

Γ is the surface tension of the liquid measured in dyne/cm, and

α is the liquid-solid contact angle measured in degrees.

With a given liquid, the work of adhesion increases with the cosine of the liquid-solid contact angle (reaching a maximum where the contact angle α is zero).

Work of adhesion is one useful tool in understanding and quantifying the surface energy characteristics of a given surface. Another useful method which could be utilized to characterize the surface energy characteristics of a given surface is the parameter labeled "critical surface tension", as discussed in H. W. Fox, E. F. Hare, and W. A. Zisman, J. Colloid Sci. 8, 194 (1953), and in Zisman, W. A., Advan. Chem. Series No. 43, Chapter 1, American Chemical Society (1964. More detailed discussions of the physical nature of surface energy effects and capillarity may be found in Textile Science and Technology, Volume 7, Absorbency, edited by Portnoy K. Chatterjee (1985), and Capillarity, Theory and Practice, Ind. Eng. Chem. 61,10 (1969) by A. M. Schwartz. Each of the above-identified references is hereby incorporated herein by reference.

Preferably, the regions of the treated web that are provided with the surface treatment have a work of adhesion for water in the range of about 0 erg/cm^2 to about 150 erg/cm^2, more preferably in the range of about 0 erg/cm^2 to about 100 erg/cm^2, and most preferably in the range of about 0 erg/cm^2 to about 75 erg/cm^2. Preferably, the remainder of the web surrounding the treated regions has a work of adhesion for water in the range of about 0 erg/cm^2 to about 150 erg/cm^2, more preferably in the range of about 25 erg/cm^2 to about 150 erg/cm^2, and most preferably in the range of about 50 erg/cm^2 to about 150 erg/cm^2.

Preferably, the difference in the work of adhesion for water between the regions and the remainder of the web is greater than about 5 erg/cm^2, more preferably greater than about 25 erg/cm^2, and most preferably greater than about 50 erg/cm^2. The difference is also preferably less than about 145 erg/cm^2.

While the fluorocarbon treatment described above is a suitable means of increasing the hydrophobicity of the nonwoven layer 210, treatment with a silicone material is particularly preferred. More preferably, only the outer surface 210A (i. e. that surface not in contact with the film layer 250) of the nonwoven layer 210 is treated with a silicone material. In particularly preferred embodiments, the treatment material is applied at a level of at least about 0.1 gram/m^2,

preferably at least about 0.2 grams/m^2. The level of treatment material is less than about 5 grams/m^2, preferably less than about 3 grams/m^2, more preferably less than about 1 gram/m^2. A particularly preferred embodiment has between about 0.4 grams/m^2 and about 1 gram/m^2 of a silicone material applied to outer surface.

Alternatively, the nonwoven layer 210 and the film layer 250 can be combined such that the treated surface is inner surface 210B. Such structures are believed to have slightly improved wetback performance and slightly inferior liquid strikethrough performance compared to the preferred location of the treated surface discussed above.

A suitable means of treating the outer surface 210A of the nonwoven layer 210 is described in U.S. Patent 5,658,639, issued to Curro, et al. on August 19, 1997, the disclosure of which is incorporated herein by reference. As described therein, a precursor web is first treated with a surface treatment which has a lower surface energy than the precursor web (e. g. a silicone materials). The treated web is then apertured using substantially the same method described in the aforementioned U.S. Patent 5,628,097.

With respect to the present invention, the nonwoven layer is preferably first apertured as described above and then treated with a surface treatment intended to reduce the surface energy of the outer surface. As noted above, while a fluorocarbon material is suitable for such treatment, silicone materials are particularly preferred.

A suitable surface treatment is a silicone release coating from Dow Corning of Midland, Mich. available as Syl-Off 7677 to which a crosslinker available as Syl-Off 7048 is added in proportions by weight of 100 parts to 10 parts, respectively. Another suitable surface treatment is a coating of a silicone material that can be cured (crosslinked) by exposure to ultraviolet (UV) light. Exemplary materials include a silicone resin UV 9300 and a UV activated photo-initiator UV 9380C-D as are commercially available from General Electric Company, Silicone Products Division, of Waterford, NY. Such materials are blended and then exposed to UV light which initiates the crosslinking reaction. A particularly preferred silicone material for treatment is a blend of silicone resin UV 9400 and UV activated photo-initiator 9380C-D1 also available from General Electric which are blended in proportions by weight of 97.5 parts to 2.5 parts respectively. The surface energy of the silicone material on the first surface of the nonwoven web is less than the surface energy of the individual fibers forming the nonwoven layer 210 so outer surface 210A has a lower surface energy than interior portions of the nonwoven layer 210.

While the surface treatment may be applied by the spraying techniques described in the aforementioned U.S. Patent 5.658,639. any technique for applying a liquid to a surface known to the art may be used. Exemplary techniques include: spraying as mentioned above, extrusion, padding, foaming (e. g. treatment with a foamed composition containing the surface treatment so as to increase penetration of the surface treatment), and printing. Particularly preferred is to print the silicone material onto the outer surface 210A using an Anilox roll to meter a controlled amount of the silicone material onto one or more transfer rolls which deposit the silicone material onto the outer surface 210A. The deposited material can then be cured using suitable means as determined by the specific crosslinking chemistry chosen. For example, chemical means (e.g. chemical crosslinking agents), thermal means (e.g. thermal crosslinking agents), or exposure to ultra violet light may be used. For the particularly preferred UV activated photo-initiator UV 9380C-D1, the coated web is exposed to ultraviolet light to cure (i.e. crosslink) the silicone material.

Film Layer

Still referring to Figures 1 and 2, the apertured thermoplastic film layer 250 is liquid permeable and positioned beneath the nonwoven layer 210. Formed films are preferred for the apertured thermoplastic film layer 250 because they are pervious to liquids and yet non-absorbent. Suitable resins for forming the apertured thermoplastic film layer 250 include: polycaprolactone; polyvinyl alcohol; polyesters; nylons; and polyolefins, particularly polyethylenes, polypropylenes and copolymers having at least one olefinic constituent. Polyethylene resins are particularly preferred.

The material used to produce the apertured thermoplastic film layer 250 should also be hydrophilic so as to provide a driving force causing bodily fluids that may be disposed on the nonwoven layer 210 to be drawn away from that layer. The apertured thermoplastic film layer 250 can comprise a hydrophilic material or, alternatively the layer can be treated so as to cause it to become hydrophilic. Exemplary means for such treatment include spraying the surface as is described in U.S. Patent 4,950,264 which issued to Osborn on August 21, 1980 and incorporating a surfactant into the polymer used to form the film as described in the aforementioned SIR H1670. One of skill in the art would recognize that, depending on the intrinsic hydrophilicity of the resin chosen and the degree of hydrophilicity desired, addition of a surfactant as described above may or may not be necessary.

The structure of the film layer 250 is shown more clearly in Figure 3 which is an enlarged, partially segmented, perspective illustration of a particularly preferred embodiment of an apertured,

macroscopically expanded, three-dimensional, fluid-pervious, formed film generally in accordance with the teachings of commonly assigned U.S. Pat. No. 4,342,314 issued to Radel on August 3, 1982, which is hereby incorporated herein by reference.

Other suitable apertured, macroscopically expanded, three-dimensional polymeric webs are also described in U.S. Pat. No. 3,929,135 issued to Thompson on December 30, 1975; U.S. Pat. No. 4,324,246 issued to Mullane, et al. on April 13, 1982; U.S. Pat. No. 4,463,045 issued to Ahr, et al. on July 31, 1984; and U.S. Pat. No. 5,006,394 issued to Baird on April 9, 1991. Each of these patents are incorporated herein by reference.

The term "macroscopically expanded", when used to describe three-dimensional plastic webs of the present invention, refers to webs, ribbons and films which have been caused to conform to the surface of the three-dimensional forming structure so that both surfaces thereof exhibit a three-dimensional forming pattern of surface aberrations corresponding to the macroscopic cross-section of the forming structure, a surface aberrations comprising the pattern are individually discernible to the normal naked eye, i.e., a normal naked eye having 20/20 vision unaided by an instrument that changes the apparent size or distance of an object or otherwise alters the visual powers of the eye, when the perpendicular distance between the viewer's eye and the plane of the web is about 12 inches. As can be seen in Figure 3, the web's fiber-like appearance is comprised of a continuum of fiber-like elements, the opposed ends of each of the fiber-like elements are interconnected to at least one other of the fiber-like elements. The term "fiber-like", as utilized herein to describe the appearance of plastic webs of the present invention, refers generally to any fine scale pattern of apertures, random or non-random, reticulated or non-reticulated which connote an overall appearance and impression of a woven or nonwoven fibrous web when viewed by the human eye.

In the embodiment disclosed in Figure 3, the interconnected fiber-like elements form a pattern network of pentagonally shaped capillaries 241. The web 250 which exhibits a fiber-like appearance, embodies a three-dimensional microstructure extending from the web's uppermost, or inner surface 250B in plane 243 to its lowermost or outer surface 250A in plane 245 to promote rapid fluid transport from the uppermost surface 250B to the lowermost surface 250A of the web without lateral transmission of fluid between adjacent capillaries 241. As utilized herein, the term "microstructure" refers to a structure of such fine scale that its precise detail is readily perceived by the human eye only upon magnification by microscopic or other means well known in the art.

Apertures 247 in the inner surface 250B are formed by a multiplicity of intersecting fiber-like elements, e.g., elements 248, 249, 251, 252, and 253 interconnected to one another in the inner surface 250B. Each fiber-like element comprises a base portion, e.g., base portion 254, located in

plane 243. Each base portion 254. has a sidewall portion, e.g., sidewall portions 256, attached to each edge thereof. The sidewall portions 256 extend generally in the direction of the second surface 250A of the web. The intersecting sidewall portions of the fiber-like elements are interconnected to one another intermediate the first and second surfaces of the web and terminate substantially concurrently with one another in the plane 245 of the outer surface 250A.

In the embodiment shown in Figure 3, the interconnected sidewall portions 256 terminate substantially concurrently with one another in plane 245of outer surface 250A to form apertures 258 in the outer surface 250A of the web. The network of capillaries 241 formed by the interconnected sidewall portions 256 between apertures 247 and 258 allow for free transfer of fluids from the inner surface of the web directly to the outer surface of the web without lateral transmission of the fluid between adjacent capillaries. It will be recognized that the area of apertures 247 in inner surface 250B is not, necessarily, the same as the area of apertures 258 in outer surface 250A.

As noted above, apertured thermoplastic film layer 250 is provided with a plurality of capillaries 241 therethrough which allow bodily fluids to pass through the film layer 250 and the composite web 70 when the web 70 is used as a topsheet. Formed films suitable for use as a thermoplastic film layer 250 of the present invention have an effective size between about 0.05 mm^2 and about 0.40 mm^2, preferably between about 0.15 mm^2 and about 0.3 mm^2. Such suitable films have a percent open area between about 15% and about 40%, preferably between about 20% and about 40%. Suitable formed films are manufactured by Tredegar Industries, Inc. of Terre Haute, IN under the trade name VISPORE. A particularly preferred formed film, with an effective size of about 0.25 mm^2 and a percent open area of about 33%, is manufactured by Tredegar and is marketed as "Dri-Weave" on sanitary napkins produced by The Procter & Gamble Company of Cincinnati, OH.

As will be recognized by comparing the effective size of the film capillaries 241 and the nonwoven apertures 204, the film capillaries 241 are smaller than the nonwoven apertures 204 so as to encourage capillary transport of fluids into the core 42 and to minimize rewet. In order to encourage such transport, the film apertures should have an effective size at least about 10% less than the effective size of the nonwoven apertures 204 (i.e. the effective size of a film aperture 241 should be no greater than 90% of the effective size of a nonwoven aperture 204). Also, the effective open area of the thermoplastic formed film layer 250 should be at least equal to and preferably greater than the effective open area of the nonwoven layer 210. As a result, each nonwoven aperture 204 circumscribes at least a portion of two or more film capillaries 241.

Forming the Dual apertured, Composite Web

As noted above, the dual apertured, composite web 70 is formed by securing the nonwoven layer 210 and the thermoplastic film layer 250 in at least partial contacting relationship. The nonwoven layer 210 and the thermoplastic film layer 250 may be joined using any suitable means as may be known to the art. For example, the layers 210, 250 may be joined by: adhesive bonds, wherein the adhesive is applied in a discontinuous pattern so as to not block any of the apertures (Exemplary patterns include an array of separate lines, spirals, or spots); pressure bonds; thermal bonds; fusion bonds (e. g. via ultrasonic bonding); or combinations of such bonding means. A particularly preferred means of securing the nonwoven layer 210 and the thermoplastic film layer 250 is fusion bonding.

Method of Forming the Composite Topsheet

Fusion bonding is one step in the method of forming the composite topsheet that is shown in Figure 4. That method also includes both treating an apertured (e. g. by using the method described in the aforementioned U.S. Patent 5,628,097) nonwoven layer 210 to increase the hydrophobicity thereof as is described as being preferred in the foregoing discussion with respect to the nonwoven layer 210.

The nonwoven layer 210 may be treated to increase the hydrophobicity thereof using the method shown in Figure 4. A first parent roll 24 of nontreated nonwoven layer 210 is unwound and passes through applicator station 100 which applies the surface treatment. The applicator station comprises a supply of surface treatment material 105 which is metered onto transfer roll 110 by doctor blade 115. Surface treatment material 105 may be any of the suitable materials discussed above. The following will discuss a method suitable for application of the preferred blend of a silicone resin and a UV activated photo-initiator.

Interaction between transfer roll 110 and doctor blade 115 meters the surface treatment material 105 into the cells of the transfer roll. Transfer roll 110 may be of any suitable type for transferring and metering a predetermined quantity of material from a material supply to an applicator. Preferably, transfer roll 110 is designed to aid in application of a coating over substantially the entire surface. A suitable roll of this type is an Anilox roll which is engraved with an evenly dispersed pattern of cells.

Surface treatment material is then transferred from transfer roll 110 to metering roll 118 which further evens the distribution of the surface treatment material 105 across the width of the web of nonwoven layer material 210. A smooth roll of rubber or other polymeric material is

suitable for use as the metering roll 118. The treatment material then transfers from metering roll 118 to applicator roll 120 which dispenses the treatment material 105 onto nonwoven layer 210. Suitable applicator rolls can be made of smooth stainless steel. Preferably, applicator roll 120 has a surface velocity somewhat greater than the web velocity in order to provide a wiping transfer of treatment material 105 from applicator roll 120 to the web of nonwoven layer material 210.

The treated web then passes under UV light assembly 150 which provides sufficient ultraviolet energy to initiate the crosslinking reaction which cures the surface treatment material 105. Suitable apparatus for use as a UV light assembly 150 is available from Fusion UV Systems, Inc. of Gaithersburg, MD.

Continuing to refer to Figure 4, the fusion bonding apparatus 308 preferably comprises an ultrasonic transducer 306 and a cylinder 310. As the treated nonwoven layer 210 and the apertured thermoplastic film layer 250 (which is supplied from second parent roll 202) are forwarded between the ultrasonic transducer 306 and the anvil cylinder 310, the layers are subjected to ultrasonic vibrational energy whereupon predetermined pattern locations of the treated nonwoven layer 210 are melted and bonded to the apertured thermoplastic film layer 250 via fusion bonds. Anvil 310 has a multiplicity of discrete pattern protuberances which are generally designated 316 disposed on its outwardly facing surface 314 in a predetermined pattern which extends about the entire circumference of the anvil cylinder. The protuberances 316 are disposed in a predetermined pattern with each protuberance 316 being configured to provide a desired pattern, such as pattern 50 shown in Figure 5, in composite web 70 which is formed by the bonding process. Alternatively, the protuberances 316 may be disposed about the circumference of surface 314 so as to create other desired patterns, such as a regular repeating pattern where the layers are joined at regularly spaced predetermined locations. The protuberances 316 are preferably truncated conical shapes which extend radially outward from the surface 314 and which have circular distal end surfaces so as to be suitable for forming bonds 52 as are shown in Figures 1 and 5. Other suitable shapes for the distal end include, but are not limited to, elliptical, square, rectangular, etc. The anvil 310 is finished so that all of the end surfaces lie in an imaginary fight circular cylinder which is coaxial with respect to the axis of rotation of anvil 310. After bonding the composite web 70 is wound into parent roll 380 for further use.

Exemplary Absorbent Article

In another aspect of the present invention, the dual apertured, composite web 70 is sized so it is suitable for use as a topsheet in an absorbent article. As used herein, the term "absorbent article" refers to devices which absorb and contain body exudates, and, more specifically, refers to devices which are placed against or in proximity to the body of the wearer to absorb and contain the various exudates discharged from the body. The term "disposable" is used herein to describe absorbent articles which are not intended to be laundered or otherwise restored or reused as an absorbent article (i.e., they are intended to discarded after a single use and, preferably, to be recycled, composted or otherwise disposed of in an environmentally compatible manner).

Such use as a topsheet of an absorbent article will be illustrated by describing sanitary napkin 20 as shown in Figures 5 and 6. One of skill in the art will recognize that such description is exemplary only and that the dual apertured, composite web 70 of the present invention can also be sized so as to be suitable for use as a topsheet on all types of absorbent articles, such as infant and adult diapers, training pants, other catamenial products (e.g. pantiliners), and urinary incontinence devices.

Figure 5 shows sanitary napkin 20 in a plan view in flat out configuration. Sanitary napkin 20 has a longitudinal centerline L which defines a longitudinal direction, a transverse centerline T substantially perpendicular to the longitudinal centerline L, a body surface 20A, a garment surface 20B, two spaced apart longitudinal edges 26, two spaced apart transverse or end edges (or "ends") 28, which together form the periphery 30 of the sanitary napkin. Sanitary napkin 20 also has two end regions, which are designated first end region 32 and second end region 34. A central region 36 is disposed between the end regions 32 and 34. The end regions 32 and 34 extend outwardly in the longitudinal direction from the edges of the central region 36 about 1/8 to about 1/3 of the length of the sanitary napkin. A detailed description of the characteristics of a central region and two end regions for a sanitary napkin is contained in U.S. Patent 4,690,680 issued to Higgins on September 1, 1987. The sanitary napkin 20 has a longitudinal central region 16 disposed along the length of at least a portion of the principal longitudinal centerline L, and longitudinal side regions 18 transversely outboard of the longitudinal central region 16.

Sanitary napkin 20 can be of any thickness, including relatively thick, intermediate thickness, relatively thin, or even very thin (or "ultra thin"). An "ultra-thin" sanitary napkin 20 as described in U.S. Patents 4,950,264 and 5,009,653 issued to Osborn preferably has a caliper of less than about 3 millimeters. The embodiment of sanitary napkin 20 shown in the drawings is intended to be an example of an ultra-thin sanitary napkin. The sanitary napkin 20 of the sanitary

napkin 20 may also be relatively flexible, so that it is comfortable for the wearer. It should, however, be understood that the sanitary napkin shown is merely one embodiment, and that the present invention is not limited to absorbent articles of the type or having the specific configurations shown in the drawings.

Figure 6 shows the individual components of the sanitary napkin 20 of the present invention. Sanitary napkin 20 preferably comprises at least four primary components. These include a liquid pervious topsheet 38, a liquid impervious backsheet 40, an absorbent core 42 positioned between the topsheet 38 and the backsheet 40, and at least one acquisition component 44. The acquisition component 44 may either be a separate component positioned between the topsheet 38 and the absorbent core 42, or it may comprise part of a composite topsheet or part of the absorbent core 42. The components of the sanitary napkin 20 may be comprised of any suitable materials that are capable of being bonded in the manner described herein.

The topsheet 38 is compliant, soft-feeling and non-irritating to the wearer's skin. Further, topsheet 38 is liquid permeable, permitting liquids to readily penetrate through its thickness. In the particularly preferred embodiment discussed herein, the topsheet 38 comprises the dual apertured, composite web 70 described above. When the topsheet 38 comprises such a material, it is disposed such that the nonwoven layer 210 comprises at least a portion of the body surface 20A. Such positioning reduces the plastic feel that some wearers associate with topsheets that comprise a formed film. Such plastic feel causes them to resist placing catamenial products using formed film topsheets in contact with their skin. Further, positioning the nonwoven layer 210 on the body surface 20A provides sanitary napkin 20 with a visually different appearance from sanitary napkins using a formed film topsheet. The fibers of the nonwoven layer 210 provide a roughness to the body surface 20A such that light incident on the body surface 20A is diffused rather than being specularly reflected, thereby providing a non-glossy visible surface which reduces the wearer's perception that the web is comprised of plastic.

The dual layer structure of the dual apertured, composite web 70 has particular advantages when it is used as the topsheet 38. In addition to the improved comfort compared to formed film topsheets discussed above, the topsheets of the present invention have improved fluid handling characteristics compared to nonwoven topsheets of the prior art. Table 1 below compares several fluid handling characteristics for sanitary napkins similar to that shown in Figures 5 and 6 that use various materials as the topsheet 38. Methods for the various tests used in the comparison in Table 1 are described in the TEST METHODS section below.

Table 1

Fluid Handling Characteristic Comparison

Topsheet Type	Strike-Through (Seconds)	Wetback (mg)	Surface Appearance (Gray Scale Value)
Formed Film[1]	59	9	29
Nonwoven 1[2]	230	17	36
Nonwoven 2[3]	138	1203	44
Present Invention	83	10	28

Table 2 makes a similar comparison for two elements of tactile feel, softness and cottony texture. Methods for the various tests used in the comparison in Table 2 are described in the TEST METHODS section below.

Table 2

Tactile Feel Comparison

Topsheet Type	Softness (Panel Score)	Cottony Feel (Panel Score)
Formed Film[1]	3.9	2.3
Nonwoven 1[2]	2.9	6.4
Nonwoven 2[3]	5.9	7.5
Present Invention	5.4	6.5

1. Dri-Weave as used on Always® sanitary napkins produced by Procter & Gamble of Cincinnati, OH

2. An apertured laminate of a film disposed between two plies of nonwoven material as is available as the topsheet on LINES IDEA from Fater SpA of Pescara, Italy.

3. An apertured thermally bonded nonwoven web as is available as the topsheet on LAURIER SOFT MESH sanitary napkins as are available in Japan from Kao Corp.

As can be clearly seen, both the formed film and the composite web 70 of the present invention handle fluids much better (faster acquisition, less rewet) than a typical nonwoven topsheet. The tactile data clearly demonstrate the improved feel of the composite web 70 relative to a formed film topsheet. Further, the surface appearance (stain hiding) of composite web 70 is comparable to or better than the surface appearance of the other topsheet types. In other words, when the composite web 70 of the present invention is used as a topsheet 38, such composite topsheets have properties combining the desirable features of both formed film topsheets and nonwoven topsheets.

While not being bound by theory, it is believed that the following model explains the results shown above. Basically, the function of a topsheet, such as topsheet 38 of the present invention, is to acquire fluids as they are exuded from a wearer's body and move such fluids away from the body surface of an absorbent article, such as body surface 20A, for storage in an absorbent core, such as core 42. Desirably, the topsheets also impede such stored fluids from moving from the core back toward the body surface.

- The acquisition requirement means that a topsheet is preferably hydrophilic to rapidly acquire fluids that may be deposited thereon. However, a hydrophilic topsheet also facilitates rewet and staining.
- Formed film topsheets overcome the rewet difficulties by providing small capillaries which impede rewet. However, as noted above, some wearers consider catamenial devices that use such formed film topsheets to be uncomfortable.

Given these two, somewhat conflicting, requirements (topsheet hydrophilicity and topsheet comfort), the webs 70 of the present invention have been able to provide the fluid handling properties heretofore limited to formed films and the comfort heretofore limited to nonwovens by proper choice of properties for the apertured nonwoven layer 210 and the thermoplastic film layer 250. Specifically, the nonwoven layer 210 is hydrophobic to encourage bodily fluids to flow into the nonwoven apertures 204 where they encounter the hydrophilic thermoplastic film layer. Since the thermoplastic film layer 250 is hydrophilic, such bodily fluids are rapidly acquired and transported to the core 42 for storage. Further, the capillaries of the thermoplastic film layer and the hydrophobic nature of the apertured nonwoven layer 210 cooperate to resist rewet. The hydrophobic nature of the apertured nonwoven layer 210 also minimizes the amount of bodily fluid that remains disposed thereon so as to minimize staining and increase the comfort and clean/dry appearance of the sanitary napkin 20 of the present invention.

The acquisition component (or "acquisition layer") 44 lies beneath the topsheet 38. The terms "layer" or "web", as used herein, include but are not limited to single unfolded sheets, folded sheets, strips of material, loose or bonded fibers, multiple layers or laminates of material, or other combinations of such materials. These two terms are thus, not limited to single unfolded layers or sheets of material. The acquisition component 44 may provide void volume beneath the topsheet 38 to increase the ability of the sanitary napkin to draw liquids through the topsheet 38. In the preferred embodiment described herein, the acquisition component 44 preferably provides resiliency to lateral compressive forces so that the sanitary napkin 20 has improved resistance to bunching.

The acquisition component 44 should be liquid permeable. The acquisition component 44 is also preferably compliant, soft feeling, and non-irritating to the user's skin. The acquisition component 44 has a body-facing face (or side), and a garment-facing face. The acquisition component 44 may be of any suitable size and shape. In the embodiment shown in Figure 5, the acquisition component 44 is in the shape of a race track with slightly concave side edges. The dimensions of the acquisition component 44, however, are preferably not as large as those of the topsheet 38.

The acquisition component 44 can be made from any materials suitable for the above purposes that are capable of having the topsheet 38 fused to them. The acquisition component 44 may, for example, be comprised of woven or nonwoven materials. The fibers or other components of these materials may be synthetic, or partially synthetic and partially natural. Suitable synthetic fibers include polyester, polypropylene, polyethylene, nylon, viscous rayon, or cellulose acetate fibers. Suitable natural fibers include cotton, cellulose, or other natural fibers. The acquisition component 44 may also be at least partially comprised of cross-linked cellulose fibers. The acquisition component 44, if nonwoven, can be made by a number of different processes. These include, but are not limited to: air laid, wet laid, meltblown, spunbonded, carded, thermally bonded, air-through bonded, powder bonded, latex bonded, solvent bonded, spunlaced, and combinations of the foregoing.

In the embodiment shown in the drawings, the acquisition component 44 preferably comprises a laminate of two nonwoven materials. The uppermost layer of this laminate (or "secondary topsheet") 46 preferably comprises spunbonded polypropylene nonwoven material referred to as product No. 065MLPV60U (or "P-9") as is available from Fiberweb, North America of Washougal, WA. The underlying layer of the laminate (or "tertiary topsheet") 48 preferably comprises a multi-bonded air laid nonwoven material that is thermally bonded using powder bonding and latex bonding. A suitable multi-bonded air laid nonwoven is available from Merfin Hygienic Products, Ltd. of Delta, British Columbia, Canada as product No. 90830X312. These two nonwoven layers are preferably laminated together by depositing the multi-bonded air laid nonwoven material on the spunbonded polypropylene nonwoven material. The spunbonded material is used as a process aid or carrier web in the process of forming this laminate.

In alternative embodiments, the spunbonded polypropylene nonwoven material may have a greater or a lower basis weight, or it may be replaced by an air laid tissue, a wet laid tissue, or any of the materials described above. If a wet laid tissue is used instead of a polypropylene nonwoven material, the orientation of the laminate is preferably reversed so that in the finished

product, the multi-bonded air laid nonwoven material lies above the wet laid tissue layer. In the case of thicker sanitary napkins, any of the acquisition components described above can be used. Additionally, in one preferred thicker sanitary napkin embodiment, a low density latex bonded air laid material can be used as the entire acquisition component (that is, no tertiary topsheet is required). A low density latex bonded air laid material suitable for this purpose is a material having a basis weight of about 80 g/m^2 known as product No. FG413MHB, which is obtained from Walkisoft, USA of Mt. Holly, NC.

The topsheet 38 is generally described herein as being fused to the acquisition component 44. This has been done for simplicity of description. (It is easier to discuss one preferred embodiment than it is to simultaneously describe all possible embodiments.) The topsheet 38 may be fused to one or more other underlying components. In the broadest sense, the topsheet comprises a first component that is fused to an underlying second component. The second component may be a separate component. Alternatively, the second component could be part of another component, such as part of the topsheet, part of the core, or part of some other component. In still other alternative embodiments, the acquisition component 44 may be omitted entirely. In embodiments where the acquisition component 44 is an integral layer of the core 42 or omitted entirely, the topsheet 38 may be considered to be fused to part of the absorbent core 42. In embodiments without an acquisition component 44, the absorbent core 42 can be comprised of at least some types of fibers (preferably synthetic fibers) that the topsheet 38 can be fused to. A sufficient amount of these fibers are preferably located near the body-facing surface of the absorbent core 42 to facilitate the fusion. Alternatively, if the absorbent core (or other underlying component) comprises powder binder, the topsheet 38 can be fused to the powder binder in the absorbent core 42 (or such underlying component).

In the preferred embodiment shown in the drawings, the acquisition component 44 is preferably joined to the apertured thermoplastic film layer 250 of topsheet 38 by fusion bonding the faces of the composite topsheet 38 and acquisition component, nonwoven laminate 44. In one preferred embodiment, the nonwoven layer 210, the apertured thermoplastic film layer 250, and the acquisition component 44 are brought together as separate webs and joined together with fusion bonds. These components are bonded across a region of their surfaces that forms a "bonded region" 50 on the body-facing side 20A of the sanitary napkin 20.

The topsheet 38 and the nonwoven laminate 44 are preferably bonded at a plurality of discrete bonded areas (or "bonds") 52. (However, it is also within the scope of the present invention for one or more of the individual bonds 52 to contact each other so that they are not

spaced apart and discrete.) The bonded areas are preferably spaced apart and distributed over the body-facing side 20A of the sanitary napkin 20, with the exception of a portion thereof that defines an unbonded window 54 in a liquid receiving zone of the sanitary napkin 20 which lies substantially in central region 36.

The discrete bonded areas preferably comprise fusion bonds 52. The fusion can be accomplished by heat and/or pressure bonds, ultrasonic bonds, dynamic mechanical bonds, and the like. Pressure can be applied in any suitable manner, such as by moving the components to be bonded between counter-rotating rolls, placing the materials on an anvil and forcing a platen down on the materials, applying vacuum pressure, and the like. Suitable means that can be adapted for use in fusing the topsheet 38 to the acquisition component 44 are described in at least some of the following patents: U.S. Patent 4,430,148 Schaefer; U.S. Patent 4,515,595 Kievit, et al.; U.S. Patent 4,531,999 Persson, et al.; U.S. Patents 4,710,189 and 4,808,252 issued to Lash; U.S. Patent 4,823,783 Willhite, Jr., et al.; and U.S. Patents 4,854,984 and 4,919,756 issued to Ball, et al.; and in allowed U.S. Patent Application Serial No. 07/944,764 filed in the name of Cree, et al. on September 14, 1992, the parent application which published June 24, 1993 as PCT Publication No. WO 93/11725.

The fusion bonding preferably comprises a plurality of individual fusion bonds 52 that are arranged in a pattern. The bonds 52 can be arranged in many different patterns. Figure 1 shows one particularly preferred bonding pattern. The individual bonds 52 that make up the pattern can be of any plan view shape. For instance, the bonds 52 can be in the form of straight or curved lines, geometric shapes such as circles, squares, rectangles, diamonds, and the like, or irregular shapes. In this embodiment, the fusion bonds 52 comprise a plurality of circular bonds. The fusion bonds 52 may be of any suitable size, and may be distributed across the body-facing side 20A of the sanitary napkin in a range of suitable densities. The fusion bonds 52 preferably have a diameter that is greater than about 1 mm and ranges up to about 3 mm. In the sanitary napkin 20 shown in Figure 5, the fusion bonds are preferably about 1.5 mm in diameter. The fusion bonds 52 preferably cover between about 5% to about 10%, and more preferably about 7% of the total surface area of the sanitary napkin 20.

The circular bonds 52 are arranged in a pattern that is preferably distributed over the entire body surface 20A of the sanitary napkin, with the exception of the unbonded window 54 in the liquid receiving zone of the sanitary napkin. The liquid receiving zone is the portion of the sanitary napkin that lies under a wearer's vaginal introitus. Preferably, the area of the unbonded window 54 is at least as large as, or larger than the projected area of a wearer's vaginal cleft so as

to intercept bodily fluids as they are exuded. Preferably, this area is greater than about 1 centimeter wide in the transverse direction and greater than about 5 centimeters long. The size of the unbonded window 54, however, is preferably not so large that the composite topsheet 38 is capable of appreciably separating from contact with the underlying acquisition component 44 in the area of the unbonded window 54 due to the lack of bonding therein. In the sanitary napkin 20 shown in Figure 5, the unbonded window 54 is preferably centered about the longitudinal and transverse centerlines. However, in other embodiments, particularly ones in which the sanitary napkin is asymmetrically-shaped about the transverse centerline, the unbonded window 54 may be offset forwardly or rearwardly relative to the transverse centerline.

In the preferred embodiment shown in Figure 5, the unbonded window 54 is defined by a plurality of fusion bonds 52 arranged in the configuration of a closed geometric figure 56. The closed geometric figure 56 is formed by a plurality of fusion bonds 52 arranged in a number of opposed, concave inwardly-oriented curvilinear lines around the unbonded window 54. The width or transverse dimension of this figure is preferably about 0.75 inches (about 1.9 cm) at its narrowest point. The length or longitudinal dimension of this figure is preferably about 3.5 inches (about 8.9 cm) as measured along the longitudinal centerline of the sanitary napkin 20.

The curvilinear lines forming the closed geometric figure preferably include a pair of longitudinally-oriented concave lines 56A. The longitudinally-oriented concave lines 56A preferably each comprise two rows of bonds where the bonds 52 in adjacent rows are arranged in a side-by-side fashion. These bonds 52 are preferably closely spaced, and as a result can wick liquids in the longitudinal direction and provide a barrier to the flow of exudates in the transverse direction, particularly menses, so that menses will not approach the longitudinal side edges 26 of the sanitary napkin 20. The ends of the closed geometric figure that surrounds the unbonded window 54 are preferably formed by curvilinear lines 56B that form cusp-shaped figures. The intersection of the two arcs comprising the cusp-shaped figures lies along the longitudinal centerline of the sanitary napkin. These curvilinear lines 56B forming the cusp-shaped figures preferably also comprise roughly two rows of bonds, but these bonds are not exactly in a side-by-side pattern.

There are also bonds 52 located longitudinally and laterally outboard of the closed geometric figure 56 in end regions 32, 34. The fusion bonding should surround the unbonded window 54. The fusion bonds 52 are preferably located in the first end region 32, the second end region 34, and in longitudinal side regions 18 of the sanitary napkin 20. The fusion bonds 52 outside the unbonded window 54 are preferably distributed over substantially all of the body-

facing side 20A of the sanitary napkin. These latter bonds 52 can also be arranged in a number of suitable patterns. Preferably, the bonding forms a "quilted pattern". More specifically, the bonds 52 are preferably arranged in a pattern that comprises a plurality of circular bonds arranged in a diamond-shaped figure 57A. The bonds that form the diamond-shaped figure 57A preferably enclose a plurality of bonds that also form a figure 57B. This enclosed figure 57B may range from a modified (or rounded) diamond shape to an oval shape. In the longitudinal side regions 18, only a portion of the diamond-shaped figures are present due to space constraints. For processing reasons, the bonds in the quilted pattern are preferably spaced apart in the longitudinal direction a distance that is equal to the radius of the bonds multiplied by the square root of three. In the transverse direction, they can be at any suitable spacing.

The acquisition component 44 can also be at least partially joined to the topsheet 38 by adhesives. If adhesives are used, the adhesives can be distributed across the entire interface between the topsheet 38 and the acquisition component 44. Preferably, however, the adhesives are not applied between these two components in the region of the unbonded window 54. Any suitable adhesives can be used for this purpose, with wet strength adhesives being preferred. Wet strength adhesives are those that retain their ability to bond in the presence of liquids. Suitable wet strength adhesives are described in U.S. Patent 5,460,622 issued to Dragoo, et al. on October 24, 1995.

If adhesives are used, they should not interfere with the transfer of liquids from the topsheet to the underlying acquisition layer or other underlying layers. The adhesives can be applied in a uniform continuous layer like meltblown fibers of adhesive, or a patterned layer, an array of separate lines, spirals, or spots of adhesive. The adhesive attachment means preferably comprises an open pattern network of filaments of adhesive as is disclosed in U.S. Pat. No. 4,573,986 issued to Minetola, et al. on March 4, 1986, or an open pattern network of filaments comprising several lines of adhesive filaments swirled into a spiral pattern as illustrated by the apparatus and method shown in : U.S. Pat. No. 3,911,173 issued to Sprague, Jr. on October 7, 1975; U.S. Pat. No. 4,785,996 issued to Ziecker, et al. on November 22, 1978; and U.S. Pat. No. 4,842,666 issued to Werenicz on June 27, 1989.

The bonding of the acquisition component 44 to the underside of the topsheet 38 over substantially the entire surface of the body-facing side 20A provides several advantages. The strength of the attachment between these layers is improved relative to the adhesively attached layers of currently marketed ALWAYS ULTRA sanitary napkins. Because of this improved attachment and the resilient nature of the materials comprising the acquisition layers, the sanitary

napkin 20 is less subject to undesirable bunching in use and is, therefore, better able to cover a maximum area of the wearer's panties (that is, "area coverage" is improved). In addition, the unbonded window 54 provides the body-facing side 20A of the sanitary napkin 20 with a region in the liquid receiving zone that is free of bonded areas to eliminate any interference with the acquisition of liquids caused by the presence of the bonds and to maximize the liquid handling capability of the sanitary napkin.

The absorbent core 42 lies under the acquisition component 44. The absorbent core 42 may be any absorbent means that is capable of absorbing or retaining liquids (e.g., menses and/or urine). The absorbent core 42 has a body-facing surface, a garment-facing surface, side edges, and end edges. The absorbent core 42 may be manufactured in a wide variety of sizes and shapes (e.g., rectangular, oval, hourglass, dog bone, asymmetric, etc.). In the preferred embodiment shown in the drawings, the absorbent core 42 is rectangular and is of a size that is slightly smaller than the periphery of the acquisition component 44.

The absorbent core 42 can be manufactured from a wide variety of liquid-absorbent materials commonly used in sanitary napkins and other absorbent articles. Examples of suitable absorbent materials include comminuted wood pulp which is generally referred to as airfelt; creped cellulose wadding; meltblown polymers including coform; chemically stiffened, modified or cross-linked cellulosic fibers; synthetic fibers such as crimped polyester fibers; peat moss; tissue including tissue wraps and tissue laminates; absorbent foams; absorbent sponges; superabsorbent polymers; absorbent gelling materials; or any equivalent material or combinations of materials, or mixtures of these. The configuration and construction of the absorbent core may also be varied (e.g., the absorbent core may have varying caliper zones (e.g., profiled so as to be thicker in the center), hydrophilic gradients, superabsorbent gradients, or lower density and lower average basis weight acquisition zones; or may comprise one or more layers or structures). The total absorbent capacity of the absorbent core should, however, be compatible with the design loading and the intended use of the sanitary napkin. Further, the size and absorbent capacity of the absorbent core may be varied to accommodate different uses such as incontinence pads, pantiliners, regular sanitary napkins, or overnight sanitary napkins.

In the preferred embodiment shown in the drawings, the absorbent core 42 preferably comprises a multi-bonded air laid nonwoven material. More preferably, the absorbent core 42 also comprises superabsorbent hydrogel-forming material (or absorbent gelling material) particles, and a latex binder. The absorbent core 42 preferably has a basis weight of about 125

g/yd^2 (about 150 g/m^2), including the particles of absorbent gelling material. Such a multi-bonded air laid nonwoven material is preferably obtained in roll form as product 915000X313 from Merfin Hygienic Products.

In alternative embodiments, the multi-bonded air laid nonwoven material used for the absorbent core can be bonded using some material other than latex (such as starch or PVA, for example). In another alternative embodiment, the absorbent core can be formed as a laminate that preferably also has a basis weight of about 150 g/m^2 and comprises two (or more) layers of multi-bonded air laid nonwoven material with the particles of absorbent gelling material therebetween. Suitable laminate absorbent core structures are described generally in U.S. Patents 4,950,264 and 5,009,653 issued to Osborn, U.S. Patent 5,460,623 issued to Emenaker, et al. Another suitable absorbent core is described in U.S. Patent Application Serial No. 08/122,114, entitled "Sanitary Napkin Having Core Predisposed To A Convex Upward Configuration", filed in the name of Hines, et al. on September 16, 1993 (PCT Publication No. WO 95/07674, published March 23, 1995).

In the case of thicker sanitary napkins, the absorbent core 42 is preferably comprised of airfelt. Suitable absorbent cores for thicker sanitary napkins are described in U.S. Patent 5,234,422 issued to Sneller, et al. In a preferred embodiment, the topsheet 38, acquisition component 44, and absorbent core 42 can be provided with embossed channels as shown in the Sneller, et al. patent. If such embossed channels are used, they preferably lie laterally outside of the longitudinally-oriented concave lines 56A defining the sides of the unbonded window 54.

The backsheet 40 prevents the exudates absorbed and contained in the absorbent core 42 from wetting articles which contact the sanitary napkin 20 such as pants, pajamas and undergarments. The backsheet 40 is preferably resistant to the flow of liquids, and more preferably is impervious to liquids (e.g., menses and/or urine). The backsheet 40 is preferably manufactured from a flexible material. As used herein, the term "flexible" refers to materials which are compliant and will readily conform to the general shape and contours of the human body. The backsheet 40 may comprise a woven or nonwoven material, polymeric films such as thermoplastic films of polyethylene or polypropylene, or composite materials such as a film-coated nonwoven material. Preferably, the backsheet 40 is a polyethylene film having a thickness of from about 0.012 mm (0.5 mil) to about 0.051 mm (2.0 mils). The backsheet 40 may be embossed and/or matte finished to provide a more clothlike appearance. Further, the backsheet 40 may permit vapors to escape from the absorbent core 42 (i.e., breathable) while still preventing exudates from passing through the backsheet 40. A suitable backsheet material is obtained as

product No. 18-1401 from the Clopay Corporation of Cincinnati, Ohio. A suitable breathable backsheet material is a laminate of an apertured film such as that described in U.S. Patent 3,929,135 issued to Thompson which is inverted so that the smaller openings of the tapered capillaries face the absorbent core 42 which is adhesively laminated to a microporous film such as that described in Exxon's U.S. Patent 4,777,073.

The topsheet 38, the acquisition component 44, the backsheet 40, and the absorbent core 42 may be assembled in a variety of configurations known in the art (including layered or "sandwich" configurations and wrapped or "tube" configurations). Figures 5 and 6 show a preferred embodiment of the sanitary napkin 20 assembled in a sandwich construction. In Figures 5 and 6, the topsheet 38 and the backsheet 40 have length and width dimensions generally larger than those of the absorbent core 42. The topsheet 38 and the backsheet 40 extend beyond the edges of the absorbent core 42 to form portions of the periphery 30. The garment-facing side of the topsheet 38 is preferably joined to the body-facing side of the acquisition component 44 as described above. The acquisition component 44 may be joined to the absorbent core 42, if desired. If these components are joined, they can be joined in any of the manners described herein for joining the topsheet 38 to the acquisition component 44. However, in the embodiment shown in the drawings, the acquisition component 44 is not directly joined to the absorbent core 42. The backsheet 40 is preferably joined to the garment-facing side of the absorbent core by adhesives.

The portions of the topsheet 38 and backsheet 40 that extend beyond the edges of the absorbent core 42 and the acquisition component 44 are preferably also joined to each other. These portions of the topsheet 38 and backsheet 40 can be joined in any suitable manner known in the art. The term "joined", as used in this specification, encompasses configurations in which an element is directly secured to another element by affixing the element directly to the other element; configurations in which the element is indirectly secured to the other element by affixing the element to intermediate member(s) which in turn are affixed to the other element; and configurations in which one element is integral with another element, i.e., one element is essentially part of the other element. Preferably, in the embodiment shown, these portions of the topsheet 38 and backsheet 40 are joined using adhesives over substantially the entire portions that extend beyond the edges of the absorbent core.

In preferred embodiments, the sanitary napkin 20 of the present invention is also provided with attachment means 82 disposed on the garment surface 20B in at least the longitudinal central region 16 thereof. Such attachment means 82 are used to removably attach the sanitary napkin 20

to a wearer's undergarment and preferably comprise a pressure sensitive adhesive as is known to the art. The adhesive attachment means 82 are preferably covered by removable release liner 86 as is shown in Figure 6. The pressure-sensitive adhesives should be covered with release liners 86 to keep the adhesives from sticking to extraneous surfaces prior to use. Suitable release liners are described in U.S. Patent 4,917,697. A particularly preferred release liner which also serves as an individual package for wrapping the sanitary napkin is described in U.S. Patent 4,556,146 issued to Swanson, et al.

To use sanitary napkin 20 of the present invention a wearer would remove any release liner used to protect the optional adhesive fastener, position sanitary napkin 20 in the crotch area of her undergarment as desired, and draw her undergarment over her hips.

TEST METHODS

Effective Size and Open Area

Overview

Image analysis methodology is used to determine both effective size (average aperture area) and open area (percentage of web area comprising apertures) using gray scale differences.

Apparatus

Stereoscopic Microscope	Zeiss Model SV-8 with 0.5X objective lens available from Carl Zeiss, Inc. of Thornwood, NY.
Video Camera	Sony DXC 755 available from Sony Electronics, Inc. of Itasca, IL
Computer	A suitable personal computer having a 486 or newer processor and sufficient memory to run the required software may be used. A suitable computer is available from Gateway 2000, Inc. of Sioux City, SD.
Image Digitizer	Vision Plus Color Frame Grabber Board available from Imaging Technology, Inc. of Bedford, MA
Image Analysis Software	Optimas Image Analysis software, version 4.10 available from Media Cybernetics of Silver spring, MD

Method

1) Set up the sample illumination apparatus (dual gooseneck fiber optic illuminator) so as to illuminate the sample area from each side at a 45 degree angle to provide even lighting.

2) Perform a spatial calibration with the software using the manufacturer's instructions.

3) Acquire an image of the web surface using the microscope, the video camera, and the image digitizer. Images were acquired using a zoom setting of 1.6X. Five images were acquired for each sample.

4) Manually define a gray scale threshold that corresponds to an aperture by visually comparing the sample with the acquired image as displayed on the monitor of the computer. Images may be retouched to remove fibers that traverse an aperture so as to improve the accuracy of the effective size measurement.

5) Standard software routines can be used to determine effective size (average aperture area).

6) Percent open area is determined by summing the area of all (whole and partial) apertures in each image. This value is divided by the total area of the image (result expressed as a percentage) to determine the percent open area. The threshold described above corresponds to black and is used to define the hole area in the image, and this area is ratioed to the area in the entire image to determine percent open area.

7) Repeat steps 5 and 6 until at least five different areas of a sample have been evaluated. Report the average and standard deviation for effective size and percent open area.

Liquid Strike-Through Time

This test method measures the strike-through time, i.e. the time required for a known volume of liquid applied to the body surface of a topsheet material, which is in fluid contact with an underlying absorbent, to pass through the topsheet material. The method used herein is described in European Disposables and Nonwovens Association (Brussels, Belgium) standard method number 150.3-96 with the following differences:

Test Condition	EDANA Method 150.3-96	Method of Present Invention
Environmental Temperature	20±2°C	22±1°C
Relative Humidity	65±2%	50±2%
Test Fluid	Synthetic Urine	Sheep's Blood
Underlying Absorbent	Filter Paper	Standard Catamenial Core

Confining Pressure	500g/(12.5cm)^2(~0.3 kPa)	0.25 psi (1.7 kPa)
Volume of Fluid to Acquire	5ml. one insult	10 ml, one insult

Wetback

Wetback is a test designed to measure the amount of liquid which emerges from an absorbent structure through a topsheet to cause wetness on the surface of the topsheet. The method used herein is described in European Disposables and Nonwovens Association (Brussels, Belgium) standard method number 151.1-96 with the following differences:

Test Condition	EDANA Method 151.1-96	Method of Present Invention
Environmental Temperature	20±2°C	22±1°C
Environmental Relative Humidity	65±2%	50±2%
Filter Paper Type	ERT FF3	Ahlstrom (Mt. Holly Springs, PA) #632
Number of Pieces of Filter Paper	5	7
Confining Pressure	4000g/(10cm)^2(~3.9 kPa)	0.77 psi (5.2 kPa)
Test Fluid	Synthetic Urine	Sheep's Blood
Fluid Loading	3.3 times wt of filter paper	7.5 ml
Exposure Time:		
Distribution	3 Minutes Under Load	15 Minutes
Rewet	2 Minutes	15 Seconds

Surface Appearance

As utilized herein, the term "masking" is defined as the difference in intensity of reflected light between a "used" or soiled product and its initial intensity reading before use. The acceptance of a catamenial product strongly depends on the masking performance of its topsheet. In fact, good masking not only provides a cleaner and drier topsheet surface but also reflects better absorbency and less rewet of the product. Masking may be analyzed by measuring the intensity of light reflected from the product's surface after it has been wetted, in order to be able to quantify it and compare results among different products.

The intensity of the light describes the energy of the light. The incoming (incident) light beam (e.g., sun light) is reflected by the surface and creates an outgoing (reflected) light beam that has a different energy or intensity. The difference of the intensities of the incoming and outgoing beam is the energy that the surface absorbs. For instance, a black surface absorbs significantly more energy or light than a white surface. The energy that is absorbed by the black surface may be transformed into heat. For example, black cars tend to be warmer than white cars

in the summer. The intensity of the light strongly depends on the light source. The intensity of the light may be characterized using different gray levels. For example, using a 256 point scale, white is defined to have a value equal to zero (white=0) and black the value 255 (black=255). Any gray (i. e. reflected light having a darkness between white and black) will have a gray scale value between 0 and 255.

A sample product for evaluation is imaged before introduction of any fluid, i.e., in its unused condition. The sample is then loaded with a predetermined amount of a fluid simulating menses. After loading the sample is rescanned. The two scanned images are analyzed to determine the gray scale level in a predetermined area of each sample. The numerical difference in gray scale level between initial reading and the after-use reading provides a quantification of the difference in reflected light, and hence the cleanliness of the surface of the product. Low numerical differences reflect less change from pre-use condition, and hence effective "masking", while higher differences reflect a greater change from pre-use condition and hence less effective "masking".

The following is a description of suitable components and a suitable method for assessing masking performance of a fluid transport web according to the present invention.

Hardware Components

The scanner utilized is a conventional scanner, such as HP Scanner Model IIp as is available from Hewlett Packard of Palo alto CA (HP), that is connected to a personal computer, such as a Macintosh IIC as is available from Apple computer of Cupertino, CA. The computer should have at least 16 MB RAM memory in order to be able to run the scanner software and NIH Image at the same time. The monitor should have at least 256 gray levels to run the software.

Software Components

Scanner Software	DeskScan II 2.1 This software is provided by HP and designed to run with the HP Scanner IIp.
Image Analysis Software	NIH Image Version 1.44 This program allows analysis of a scanned image to determine the density of any color or gray level and the intensity of reflected light. The latest version of this shareware program is available on the internet at the following URL: codon.nih.gov (Such image analysis software is believed to perform in the same manner as Version 1.44).

Measuring Procedures

The following steps describe in detail the procedure for measuring a catamenial pad or a similar object.

Calibration File Set-Up Procedure:

Under APPLE menu, select DESKSCAN.

1. Place GRAY SCALE STANDARD (available from Stouffer Graphic Arts of south Bend, IN as part number R1215) face down on the scanner screen. HANDLE ONLY by the very EDGES AND AVOID BENDING the strip.
2. SETTINGS :

Image Type	Black & White Photo
Path	Linotronic
Brightness	114
Contrast	115

3. Scan strip by hitting PREVIEW and using mouse adjust box around strip to include the entire strip.
4. RECHECK THE SETTINGS
5. Click FINAL button
6. Save as CALIBRATION. TIFF (Be sure FORMAT is TIFF) and save to DESK TOP
7. HIDE DESKSCAN (click the icon furthest right on menu bar)
8. OPEN the image analysis software (under APPLE on menu bar)

9. Under FILE select OPEN and open the CALIBRATION.TIFF file that you just created and saved to desktop.
10. MINIMIZE(click on box in right hand corner)
11. Click on SQUARE icon, top right of tool bar.
12. Place cursor in section #1 of the strip and drag diagonally to make a box.
13. Under ANALYZE select MEASURE
14. Take a reading from the remaining 11 sections in the same method as for section #1.
15. Under ANALYZE select CALIBRATE. At this point, a table of the 12 measurements from steps 13 and 14 is displayed.
16. Enter the relative densities from the table below to correct for gray scale (Use the TAB KEY instead of "return key" to advance cursor.).

OPAQUE LEVEL 1 - 12	RELATIVE DENSITY %
1	0
2	9.1
3	18.2
4	27.3
5	36.4
6	45.5
7	54.5
8	63.6
9	72.7
10	81.8
11	90.9
12	100

17. Be sure 3rd DEGREE POLYNOMIAL is selected
18. Enter "Save" in dialog box.
19. Save as CAL TO DESK TOP
20. Enter OK in the chart's table.
21. Graph shows on the screen.
22. Close picture without saving anything.
23. Under ANALYZE select RESET
24. Enter CONTINUE
25. Under FILE select NEW

26. Calibrate the empty picture : under ANALYZE select CALIBRATE
27. Select the DIALOG BOX that says "OPEN".
28. Open file entitled CAL.
29. #'s will appear in the columns
30. Click OK
31. Graph will reappear
32. Under FILE Menu select SAVE AS
33. Save the file as CALIBRATION in TIFF format to a location from which the file can later be retrieved.
34. Close FILE
35. Close scan file (of strip) without saving anything (enter NO)
36. Delete files CAL and CALIBRATION.TIFF from desk top.

Data Determination

Sample Treatment

Each sample is scanned when it is dry (See Using the Scanner, below.) to obtain a baseline gray scale value for the sample. A measurement area is defined and a gray scale measurement is taken.

The sample is then infused with 7.5 ml of fluid in accordance with the procedure of the liquid strikethrough time test. A wet masking measurement is then taken using the infused sample using the following procedure.

1. The plate is removed as soon as fluid is absorbed (i.e. substantially no visible fluid on the surface)
2. A three minutes equilibration time is allowed to elapse for the fluid to reach an equilibrium condition within the sample.
3. The sample is then evaluated for gray scale a second time (See Using the Scanner, below.) using the same identified measurement area.
4. After scanning a wet sample, the screen is cleaned with an alcohol-impregnated low linting lens cloth (e.g. Kimwipes® as are available from Kimberly Clark corp. of Roswell,

GA). The scanner screen must always be very clean, since dirt on the screen may affect the quality of a scanned sample and the measurement.

Using the Scanner

Following steps are necessary to scan a sample with the HP IIp scanner:

Preparing the Scanner:

1. Insure the scanner is connected to the computer.

2. Start the computer.

3. Switch on the scanner.

4. Start the scanner software program (DeskScan II 2.1).

Scanning an Image:

The following steps are used when scanning either a dry or a wet (fluid treated) sample. As noted above, each sample is scanned once when it is dry and once after it has been treated with fluid.

The flatness of the sample's surface is very important, in order to get consistent results. In order to maintain the sample in a flat condition, a 12" (30 cm) metal ruler weighing about 42 grams is placed on the length of the catamenial to flatten the sample sufficiently to perform the measurements without unduly compressing or distorting the sample.

1. Place the sample on the center of the scanner screen

2. Place a weight on the sample to hold the sample flat without expelling absorbed fluids (A flat 12 inch (30 cm) metal ruler weighing about 42 grams has been found to be suitable).

3. Press PREVIEW on the menu of the program

4. Select the type of image: Choose: Black and White Photo

5. Select the print path: Linotronic

6. Select the area of the sample for evaluation.

7. Adjust the brightness and contrast

   Brightness: 114

   Contrast: 115

   These values must be set, in order to always have the same image quality.

8. Insure all the settings are correct.

9. Push the FINAL button on the scanning software menu.

   The software will request a file name and a folder location to store the file. A naming convention that identifies files by sample identifier with either a dry or wet extension has

been found to be useful (For example, SampleID.DRY would describe a scan of a dry (untreated) sample having the identifier SampleID) The file should have a TIFF format. Usually this option is preset. Insure the file is saved in TIFF format, in order to be able to open this file using the NIH Image software.

The scanner will then scan the sample again, this time slower, because it saves the picture to a file.

Data Evaluation

The following steps describe the procedure of analyzing a scanned picture.

Analyzing the Scanned Picture Using NIH Image

Customizing the Program

1. Open the NIH Image software.

2. Customize the program when using the software for the first time as described below.

a) Menu: OPTIONS

Check Gray scale

Preferences: Undo & Clipboard buffer: set to at least 1500K

Record preferences in FILE menu

b) Menu: ANALYZE

Options: Check Area and Mean Density

Digits right of . . . : set to 1

c) Restart NIH Image software to make all the settings effective.

Gray Scale Measurement

1. Open the calibration file named CALIBRATION.TIFF

2. Open the scanned file in TIFF format. If there is a system warning that the Undo Buffer is too small, add memory repeating preferences in step 2 a). The measurements for the scanned file will be automatically calibrated, as long as the CALIBRATION.TIFF file is open at the same time. You can check if the picture has been calibrated, if there is a white diamond displayed in the title bar.

3. Go to ANALYZE in the menu and select RESET

4. Start measuring

   a) Open the file from the scanned image of a dry sample.

      i) Measure the mean optical density of a 2 cm X 3 cm rectangle at the center of the sample.

      ii) Select ANALYZE in the menu and select MEASURE

      iii) Select ANALYZE in the menu and select SHOW RESULTS

      iv) Confirm that a measurement has been made and close the results table.

   b) Close the file from the scanned image of the dry sample.

   c) Open the file from the scanned image of the wet sample corresponding to the image evaluated in step a.

      i) Measure the mean optical density of a 2 cm X 3 cm rectangle centered in the stained area of the sample. This area should substantially coincide with the rectangle evaluated in step a if the sample was positioned properly when it was infused with fluid.

      ii) Select ANALYZE in the menu and select MEASURE

      iii) Select ANALYZE in the menu and select SHOW RESULTS.

      iv) Confirm that a measurement has been made and close the results table. Do not delete measurements

7. Close the file from the scanned image of the wet sample.

8. Repeat steps 4-7 until measurements on all sample replicates are completed. A minimum of 3 replicates should be evaluated for each sample type.

9. Print the results table for each set of sample replicates.

10. Repeat step 8 until all sample types have been evaluated.

Report

For each sample type, report the mean wet gray scale value, the mean dry gray scale value, and the difference between the values.

Softness/Cottony Feel

Overview

A trained panel of graders is used to compare the tactile softness of a series of test products with a standard.

Panelists

Panelists are all female and are selected and trained for ability to discriminate small differences in tactile softness. As part of this training, each panelist identifies a "dominate" (i.e. most sensitive) hand which is used in all evaluations. Panelists are retrained biannually to minimize drift with time.

Apparatus

Sensory Box A 33 cm X 43 cm (face) X 20 cm (deep) rectangular box having an open back for product presentation and a front opening screened by a black curtain (the curtain is in 2 portions each about 21 centimeters wide and separated in the middle to allow easy grader access).

Method

1) The panel moderator introduces the first product into the sensory box. Up to two test products and a control product may be evaluated in any one test period. Products are presented to each panelist in a random order.

2) The panelist washes her hands with warm water to insure they are clean and at normal body temperature (i. e. not cold from being outside or handling refrigerated items).

3) The panelist grades each product on a 9 point scale for softness and for cottony feel where, for softness, 0 is identified as not soft and 9 is identified as soft and for cottony feel, 0 is identified as plastic feel and 9 is identified as cottony feel. The panelist uses the finger tips and other parts of her dominate hand to determine a softness grade for the product. The control product (LAURIER SOFT MESH) has a defined softness level of 7 and a defined cottony feel level of 7. The control product is used to maintain consistency between tests. The grade for each product is recorded on a data table by the panelist.

4) Steps 1 and 2 are repeated for a minimum of 25 graders until all products have been evaluated by all graders.

Report

Report the mean and standard deviation for each product tested, including the control product. Known methods of determining statistically significant differences (e. g. analysis of variance) may be used.

The disclosures of all patents, patent applications (and any patents which issue thereon, as well as any corresponding published foreign patent applications), and publications mentioned throughout this description are hereby incorporated by reference herein. It is expressly not admitted, however, that any of the documents incorporated by reference herein teach or disclose the present invention.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

WHAT IS CLAIMED IS:

1. A composite, laminated web suitable for use as a topsheet for an absorbent article, said web comprising:

a liquid pervious first material and a liquid pervious second material attached to said first material forming said composite, laminated web, characterized in that:

said first material is an apertured fibrous nonwoven material having a first surface energy and being provided with nonwoven apertures, said nonwoven material having an outwardly facing first surface and an inwardly facing second surface, wherein said first surface is treated with a surface treatment so as to provide spaced apart microscopic regions having a second surface energy that is lower than said first surface energy; and

said second material is an apertured film, said film being provided with film apertures, at least some of said film apertures underlying said nonwoven apertures, said second material having an inwardly facing third surface and an outwardly facing fourth surface, said third surface being disposed in a facing relationship with said second surface and joined thereto.

2. A composite, laminated web according to Claim 1 wherein said nonwoven apertures have an effective size and said film apertures have an effective size, wherein the effective size of said film apertures is less than or equal to the effective size of said nonwoven apertures.

3. A composite, laminated web according to Claims 1 or 2 wherein said second material is a macroscopically expanded, fluid pervious formed film having an effective open area wherein said formed film is provided with capillaries defined by inter connected sidewall portions, said capillaries having an effective size such that each of said nonwoven apertures circumscribes at least a portion of two or more of said capillaries.

4. A composite, laminated web according to Claim 3 wherein said effective size of said nonwoven apertures is between about 1 mm^2 and about 10 mm^2.

5. A composite, laminated web according to any of the above claims wherein said surface energies are expressed as a work of adhesion and the difference between said first surface energy and said second surface energy is at least about 50 erg/cm^2.

6. A composite, laminated web according to any of the above claims wherein said surface treatment is selected from the group consisting of fluorocarbon materials and silicone materials, preferably said surface treatment comprises a silicone material.

7. A composite, laminated web according to any of the above claims wherein second material is attached to said first material using means selected from the group consisting of adhesive bonding, thermal bonding, ultrasonic bonding, and crimping, preferably said second material is attached to said first material using ultrasonic bonding.

8. An absorbent article comprising:

   (a) a topsheet comprising a composite, laminated web according to any of the above claims;

   (b) a backsheet joined to said topsheet; and

   (c) an absorbent structure disposed between said topsheet and said backsheet.

9. An absorbent article according to Claim 8 wherein said absorbent article is selected from the group consisting of diapers and catamenial pads.

10. A method for forming a composite, laminated web, said method comprising the steps of:

   (a) providing a nonwoven web having a first surface energy, a first surface, and a second surface;

   (b) weakening said nonwoven web at a plurality of locations creating a plurality of weakened, melt-stabilized locations;

   (c) applying a tensioning force to said weakened nonwoven web to cause said web to rupture at said plurality of weakened, melt-stabilized locations creating a plurality of nonwoven apertures in said web coincident with said plurality of said weakened, melt-stabilized locations so as to create an apertured nonwoven web;

   (d) providing an apertured macroscopically expanded three-dimensional polymeric web having a first surface and a second surface; and

   (e) joining said second surface of said apertured nonwoven web to said first surface of said apertured macroscopically expanded three-dimensional polymeric web to form said composite, laminated web.

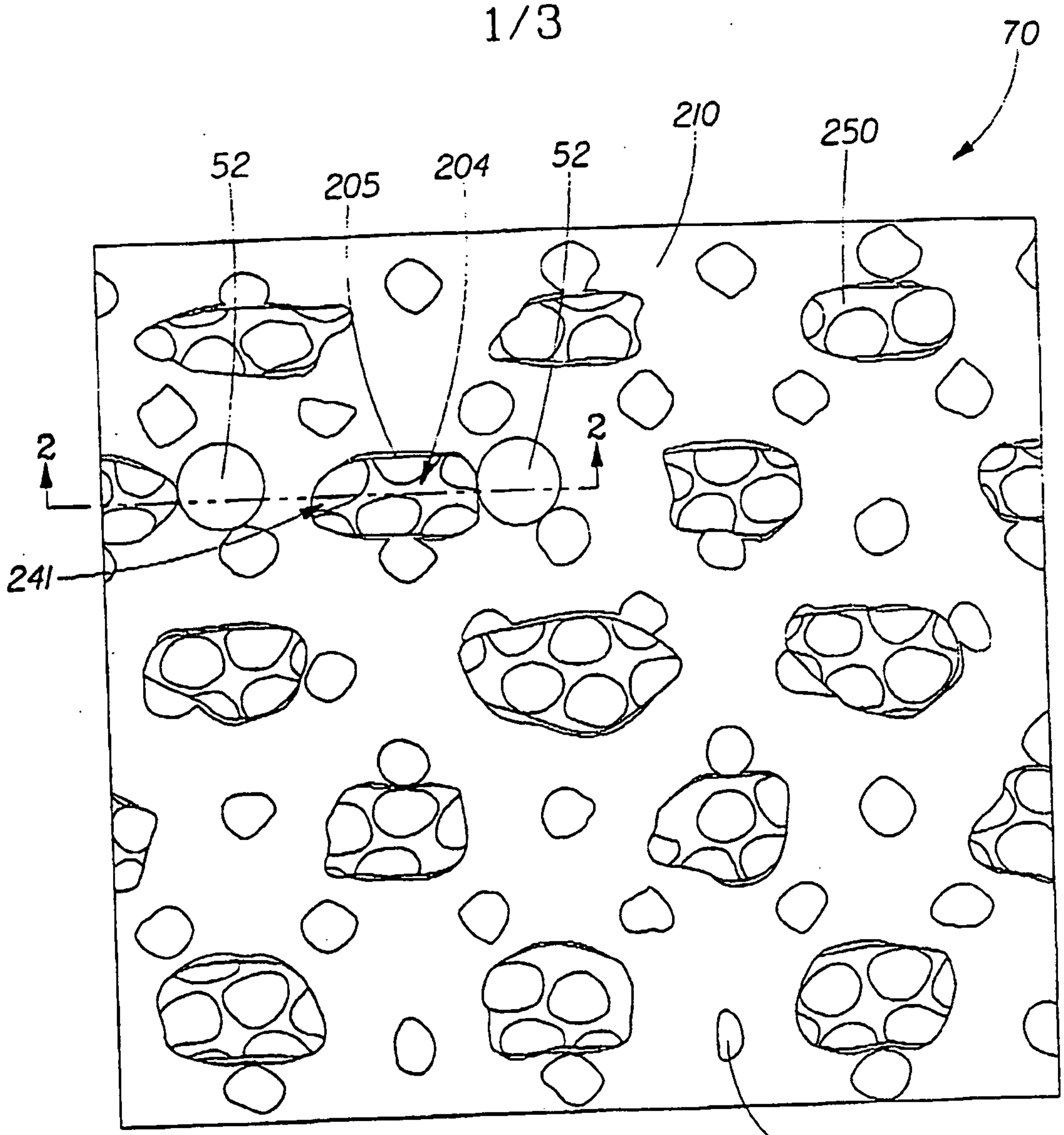

FIG. 1

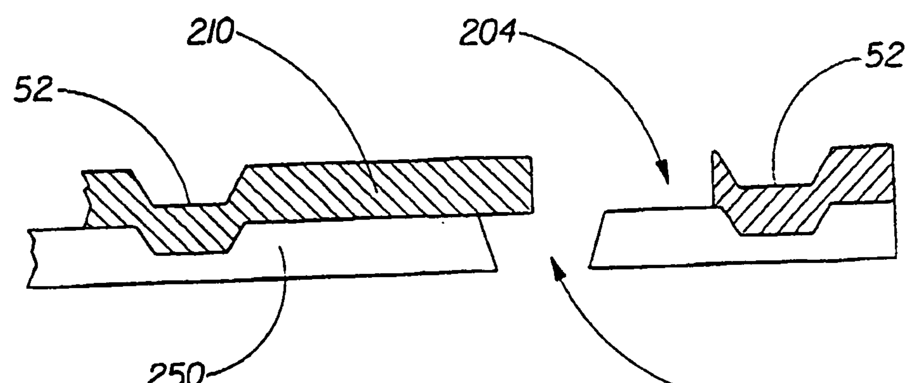

Fig. 2

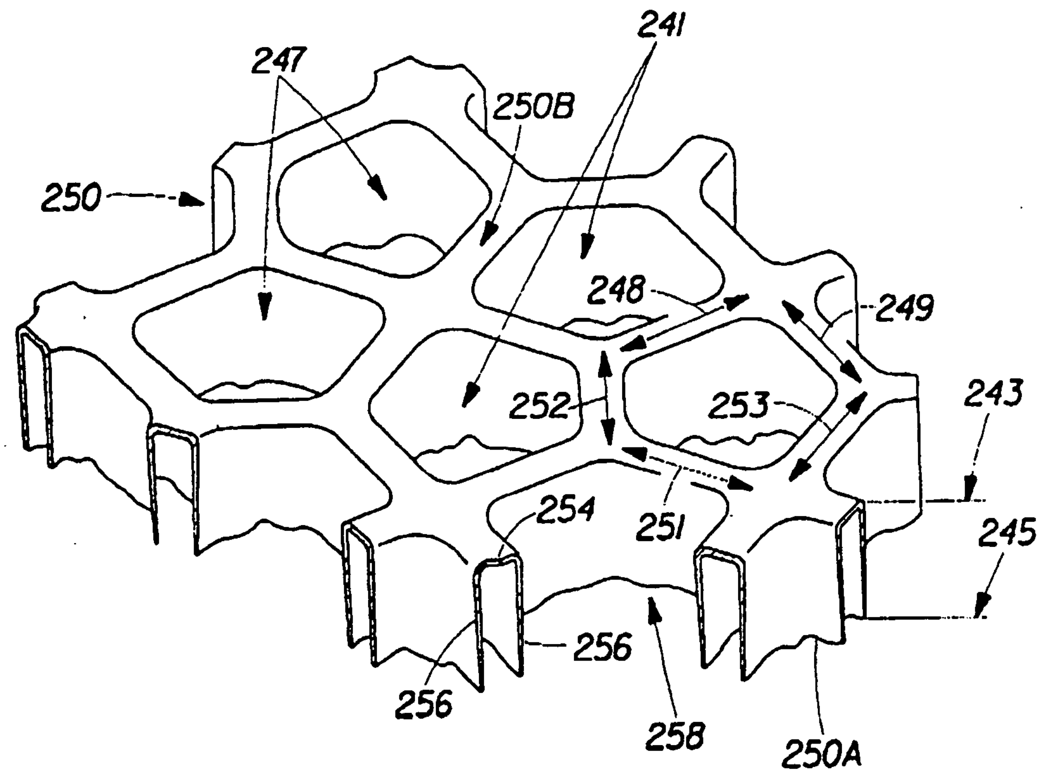

Fig. 3
(Prior Art)

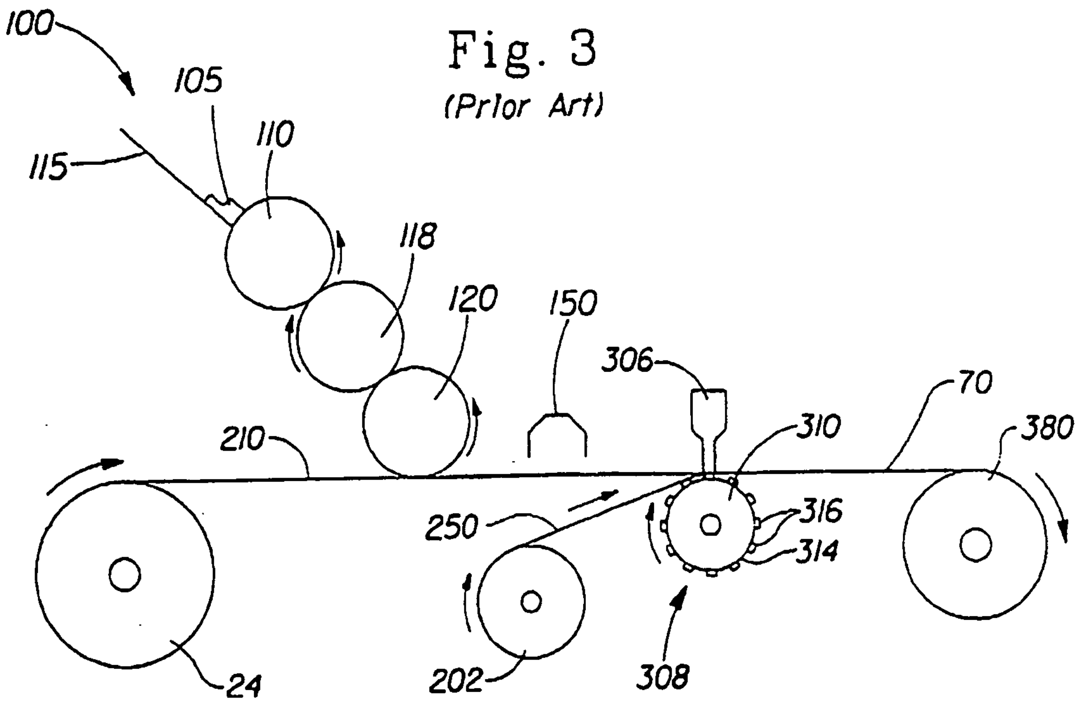

Fig. 4

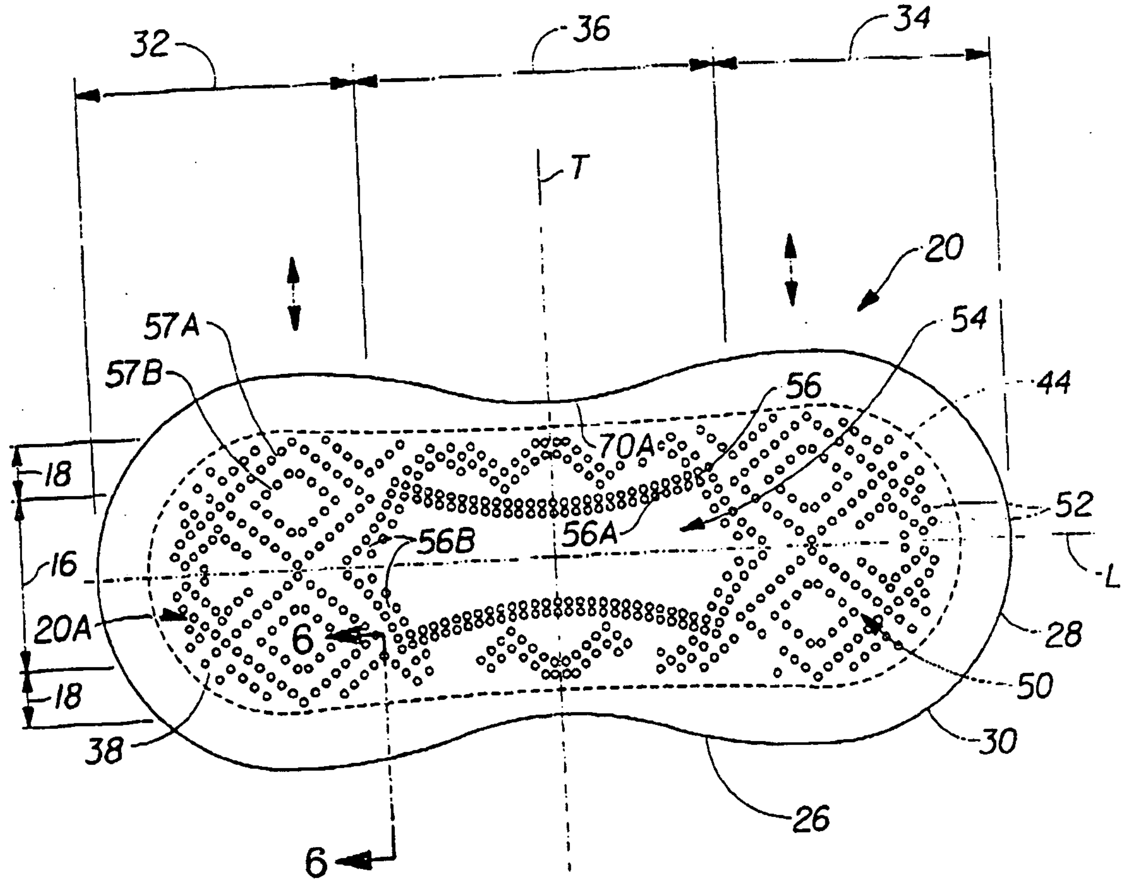
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Fig. 5

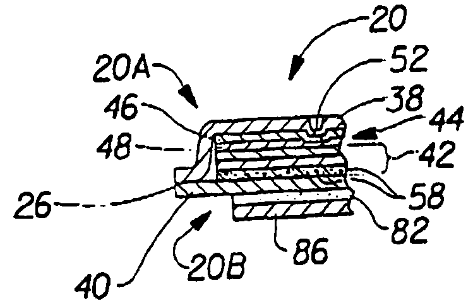
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Fig. 6

INTERNATIONAL SEARCH REPORT

Inten nal Application No
PCT/US 99/29304

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B32B3/24 B32B5/24 A61F13/15

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B32B A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 312 118 A (KIMBERLY CLARK CO) 19 April 1989 (1989-04-19) claims 1,6,7,21-24 page 4, line 11 - line 32 page 5, line 32 -page 6, line 20 examples 1-3	1-3,7,8
X	WO 98 25759 A (PROCTER & GAMBLE) 18 June 1998 (1998-06-18) cited in the application claims 1-3 page 5, line 1 - line 34 page 16, line 11 -page 17, line 25	1,5-9
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 May 2000	07/06/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Girard, S

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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